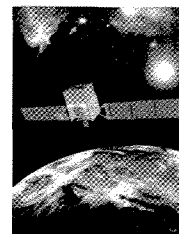


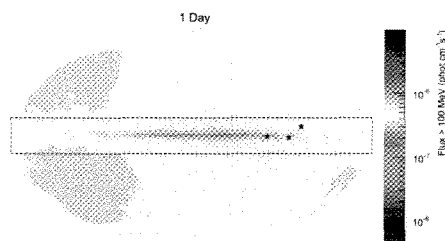
Fermi LAT Observations of Gamma-ray Transients near the Galactic Plane

E. Hays (NASA/GSFC) on behalf of the Fermi LAT Collaboration



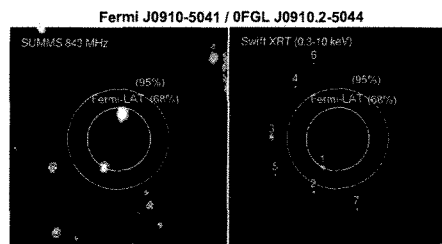
Abstract: The Large Area Telescope (LAT) on the Fermi Gamma-ray Space Telescope provides unprecedented sensitivity for all-sky monitoring of gamma-ray activity from 20 MeV to >300 GeV. The observatory scans the entire sky every three hours and allows a general search for flaring activity on daily timescales. This search is conducted automatically as part of the ground processing and allows a fast response to transient events, typically less than a day. Most flares are spatially associated with known blazars, but in several cases during the first year of observations, gamma-ray flares occurring near the Galactic plane did not reveal any initially compelling counterparts. This prompted follow-up observations in X-ray, optical, and radio to attempt to identify the origin of the emission and probe the possible existence of a class of transient gamma-ray sources in the Galaxy. We will report on the details of these LAT events and the results of the multiwavelength counterpart searches.

One-Day Point Source Sensitivity



This Galactic map shows the integrated flux ($E>100$ MeV) required for a 5 sigma detection in one day [3]. A photon index of 2.0 is assumed. The sensitivity near the Galactic Plane is dominated by Galactic diffuse gamma-ray emission. Black stars mark the locations of the unassociated LAT transients.

Multiwavelength Observations



Swift/XRT observations of the LAT error circle (0.1 deg at 95% confidence for the flare, statistical only) for a new unassociated gamma-ray source, Fermi J0910-5041, were taken one day, 2 days and 1 month following the gamma-ray peak on October 16, 2009. In the summed X-ray image (right), Source 1, which only showed marginal evidence for x-ray variability, coincided with both a SUMMS radio source [7] and a 20 GHz radio counterpart reported by Sadler et al. [9].

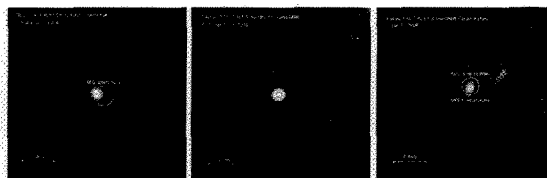
Galactic Gamma-Ray Transients?

EGRET measured variability from some sources near the Galactic Plane. One of these has since been confirmed as X-ray binary LS I +61 303. Another, GRO J1838-04, displayed a strong outburst, but multiwavelength searches of the error box did not offer a firm counterpart or favor a blazar interpretation [1] prompting speculation on a possible class of Galactic gamma-ray transients. More recently, AGILE has also reported several transients near the Galactic Plane (e.g. [2]).

Fermi LAT observations enable a sensitive search for new and recurrent transient gamma-ray sources in the Galactic Plane. The LAT observes the entire sky every 3 hours with excellent sensitivity and angular resolution in the GeV energy band. In daily monitoring of the gamma-ray sky, LAT detections near the Galactic Plane are given particular attention to distinguish possible active sources from the foreground of bright gamma-ray pulsars and diffuse background. Most importantly, the LAT localization for bright flares is sufficient for some follow-up observations to be made while the gamma-ray activity is declining.

Unassociated LAT Transients

In the first year of observations, the LAT has detected many transients [4]. Three are distinguished as bright, short (~day) flares lacking initial associations and lying within 10 deg of the Galactic Plane.



Left: LAT (white) and EGRET (green) 95% error circles for 3EG J0903-3531 [5]

Center: LAT 95% error circle (green) for Fermi J0910-5041 [6]

Right: LAT 95% confidence region for the flare (cyan) and the nine-month source position (green) for Fermi J1057-6027 [9]. The flare had the shortest duration and softest spectrum of the unassociated, low latitude transients making it less significant (~5 sigma) over foreground and background emission.

Discussion

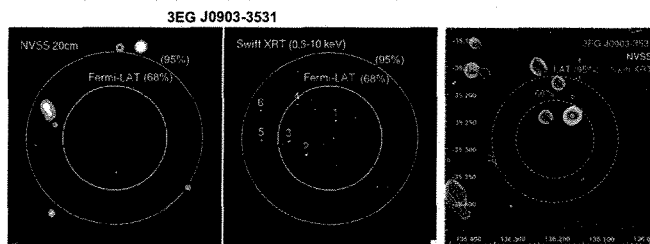
None of the three unassociated LAT transients is firmly identified. However, the presence of flat-spectrum radio and X-ray sources within the 95% confidence regions for both Fermi J0910-5041 and 3EG J0903-3531 suggests a possible blazar origin in both cases. Such associations are not entirely satisfactory without observations of correlated variability.

The absence of a flat-spectrum radio counterpart in the error circle of Fermi J1057-6027 is intriguing, but does not eliminate the possibility of a blazar origin for the gamma-ray brightening. It does indicate relatively weak radio emission for a gamma-ray blazar. Clear separation of a potential transient from background and foreground gamma-ray sources becomes significantly more difficult closer to the inner Galaxy. Further evaluation of the error region defined by the flare emission is desirable.

We note that the continued mapping of blazar activity near the plane is a necessary component to improve searches for variability in Galactic sources themselves. The short, bright outbursts that are most easily detected at low latitude are not the most common variability signature observed in high latitude LAT blazars [10].

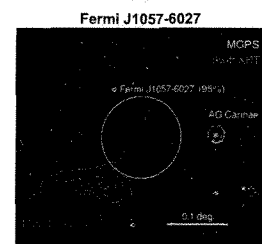
The LAT all-sky scanning observations and flare advocate monitoring of the gamma-ray sky are ongoing and ensure continued coverage of these sources in the event of renewed gamma-ray activity.

- [1] Tavani, M., et al., *ApJ*, 479, L109 (1997)
- [2] Chen, A., et al., *The Astronomer's Telegram*, 1308 (2007)
- [3] Atwood, W. B. et al., *ApJ*, 697, 1071 (2009)
- [4] LAT Monitored Source List Light Curves, <http://fermi.gsfc.nasa.gov/ssc/data/access/lat/msl.html>
- [5] Hays, E., Cheung, C. C., & Reyes, L., *The Astronomer's Telegram*, 1771 (2008)
- [6] Cheung, C. C., Reyes, L., Longo, F., & Ioffe, G., *The Astronomer's Telegram*, 1788 (2008)
- [7] Landi, R., Sguera, V., Bassani, L., Buzzano, A., De Rosa, A., Dean, A. J., *The Astronomer's Telegram*, 1821 (2008)
- [8] Sadler, E. on behalf of the AT20G team, *The Astronomer's Telegram*, 1843 (2008)
- [9] Yasuda, H., Takahashi, H., McConville, W., *The Astronomer's Telegram*, 2081 (2009)
- [10] Abdo, A. A. et al., *ApJ*, 700, 597 (2009)



The LAT error circle (0.2 deg at 95% confidence, statistical) for a LAT flare coincident with 3EG J0903-3531 on October 5-7, 2008. Swift/XRT observations of this location were taken on the last day of the outburst, several days, and several weeks later. No compelling counterparts were found in archival radio data (left) or the original summed Swift data (center).

An updated LAT analysis using 8 months of data and aided by faint, persistent gamma-ray emission provided a more accurate and slightly shifted position. Swift/XRT observations (right panel, color map) of the new LAT position (cyan) revealed a likely X-ray counterpart that coincides with a flat-spectrum radio object (right panel, contours) just outside the original LAT error circle.



The June 11 2009 outburst coincided with a LAT source detected in 9 months of data having a 95% error radius (white) of 0.07 deg (statistical). No likely X-ray (ATels #2082, #2083) or radio counterparts have been found. The LBV star AG Carinae is more than 7 arcmin outside the 95% error radius.